

Planar Defect Experiments at Nova

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Target defects are relatively small physical features in target construction which could limit the symmetry of an implosion, hence degrading the yield. We have studied in planar geometry the physics of the target interaction of two such features: gaps in the outer surface of ablators due to construction techniques involving fill plugs, and material-filled joints of copper-doped beryllium ablators for NIF targets. For both studies, transverse radiography was used to observe targets mounted on the side of Nova hohlraums. The hohlraums were driven by 1 ns flat pulses totaling about 20 kJ in energy. The geometry is shown in Figure 1.

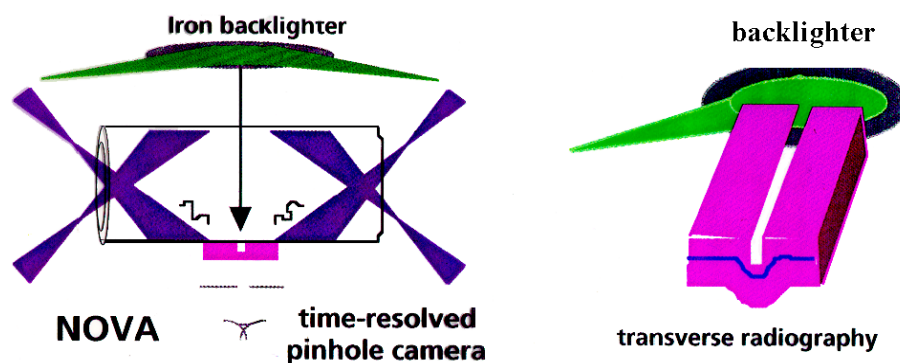


Figure 1. Configuration with a gap target. Joints are cracks which go entirely through the target and are filled with material.

Gap studies have involved proof-of-principle experiments coupled with Lasnex and/or Rage calculations. The shock Mach number is of order 10 in the experiments. The target material is brominated polystyrene (C_8H_7Br) to minimize radiative preheat through the shock front. Gated x-ray imaging can determine the locations in two-dimensions of the shock and ablation fronts.

The first targets were slabs with a rectilinear gap in the surface facing the hohlraum extending partially through the slab. The correlation between the shaped ablation front due to the gap and the shock front was found as a function of time. The shock front in the vicinity of the gap first leads the front farther away, but at longer times it begins to lag behind. The presence of a gap in a planar target does not always lead to jetting of material on the far side. As shown in Figure 2, Rage simulations have modeled the experiment qualitatively. The change in location of the most advanced point along the shock front is an effect similar to the oscillatory behavior in the propagation of a linearized rippled shock due to uniform irradiation on an initially rippled surface [R. Ishizaki and K.

Nishihara, Phys. Rev. Letters 78, 1920 (1997)], but the gap problem, with the ratio of gap depth to gap width of order unity, is nonlinear.

Experiments on joints have been stimulated by Cu-doped Be ablaters for NIF targets. In similarity to the gap problem, targets have been studied by transverse radiography in planar geometry with the transverse dimension of the joint limited to values above the minimum diagnostic resolution. The experiment included 15-micron-thick rectilinear slots that extended through foils of 150-micron-thick beryllium-copper (10 wt % Cu). These slots or joints are filled with aluminum or plastic to mock up joints in the NIF ablaters. The aluminum joint-fill and the plastic joint-fill mock up high-density joint and low-density perturbations, respectively. The shock close to the joint lags behind the shock far from the joint by a distance roughly equal to the joint width in the aluminum experiment. This lag vanishes at a lateral distance from the joint of $c_s t$ (sound speed multiplied by the time since the shock entered the material). For our experimental conditions this was about ten times the joint thickness. For a plastic joint, the shock front and the ablation front lead in the joint. This produces a complex behavior where a shock leads in the material near the joint, but a lower pressure is generated behind the ablation front in the plastic and ahead of the ablation front in the Be/Cu. The data compares well with calculations for both scenarios.

In furnishing some interesting and suggestive pictures of defect phenomenology, the planar defect experiments have established the value of transverse radiography as a diagnostic technique for target defect problems. The capability of modeling experiments with defects, at least semi-quantitatively with Lasnex and with the Rage AMR code, provides a starting point for the study of more complex scenarios. We anticipate future problem areas to include simple defects in more complicated planar geometries and defect problems in convergent cylindrical geometry.

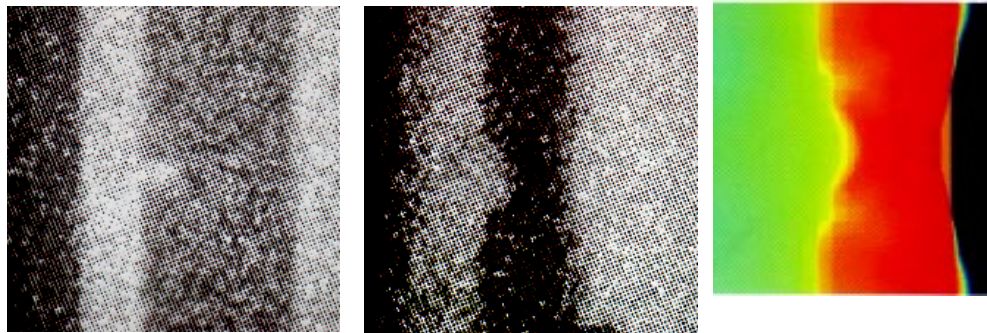


Figure 2. Left, backlit view of initial target; center, backlit view of target at shock breakout; right, Rage simulation of breakout.